# OPTICAL DISK WITH PRERECORDED CONTROL INFORMATION

## BACKGROUND OF THE INVENTION

### Field of the Invention

The present invention relates to an optical disk and an optical disk apparatus for readily acquiring information about the disk itself such as a track pitch, a recording linear velocity and a recording angular velocity of the loaded optical disk during recording or reproduction.

### Description of the Related Art

During recording or reproduction of disks with a constant recording linear velocity, it is beneficial to acquire beforehand the target recording linear velocity of an optical disk to be used. When the disk stops at a certain position in the radial direction and then restarts rotating, it is possible to accurately set an adequate rotational speed of the disk for providing the target recording linear velocity, if the same is acquired previously. The target recording linear velocity can be reached in a short time. If there are previously acquired both of the track pitch and the recording linear velocity, it is possible to accurately set a track jump target distance (or a target feed amount of an optical pickup) toward a destination address to be accessed, and an adequate rotational speed of the disk for providing the target recording linear velocity at the access destination. This enables an access to the target position in a short time and to promptly start recording or

reproduction.

Likewise, during recording or reproduction of disks with a constant recording angular velocity, it is also beneficial to acquire beforehand the target recording angular velocity of an optical disk to be used. When the disk stops and then starts rotating, the target recording angular velocity can be resumed in a short time. If there are previously acquired both of the track pitch and the recording angular velocity of an optical disk to be used, it is possible to accurately set a track jump target distance (or a target feed amount of an optical pickup) toward a destination address to be accessed. This enables an access to the target position in a short time and to promptly start recording or reproduction.

There is a case of adjusting the time axis correction amount for a recording signal or the laser beam's recording power according to the recording linear velocity. The recording linear velocity must be previously recognized to set the time axis correction amount.

A flowchart in FIG. 2 is used to exemplify a procedure for acquiring information about a track pitch and a recording linear velocity when an optical disk of a constant recording linear velocity mode is loaded on a conventional optical disk apparatus (e.g., CD-R/RW drive apparatus). When the optical disk is loaded (S1), a disk type (CD-ROM, CD-R, CD-RW, etc.) is detected (S2) and the TOC (Table of Contents) information is acquired (S3). Then, an optical pickup is

moved to a position within a radius of 25 mm, i.e., a start position of a program region (S4). At this position, a spindle motor is controlled to acquire a specified wobble frequency or RF frequency. The spindle motor's rotation number is measured at that time (S5). Based on this measurement result, the recording linear velocity is computed (S6). Thereafter, the optical pickup moves to a position within a radius of 40 mm, i.e., a middle of the program region (S7). The time information at that position is acquired (S8). The track pitch is computed based on that time information and the previously acquired recording linear velocity (S9). Thus, the information about the track pitch and the recording linear velocity has been acquired (S10).

The conventional optical disk apparatus spends a lot of time for preparing for recording or reproduction because loading the optical disk necessitates complicated processing as shown in FIG. 2.

## SUMMARY OF THE INVENTION

The present invention has been made in consideration of the foregoing. It is therefore an object of the present invention to provide an optical disk and an optical disk apparatus for fast acquiring information about the disk itself such as a track pitch, a recording linear velocity and a recording angular velocity of the optical disk during recording or reproduction.

The optical disk according to the present invention

records preliminarily (during a disk manufacturing process) the track pitch information and/or the recording linear velocity information or the recording angular velocity information as control information about the optical disk itself. Just by reading the disk, it is possible to acquire these types of information. Accordingly, it is possible to eliminate the need for measurement, to acquire these types of information in a short time, and to shorten the time for preparing for recording or reproduction. This optical disk can preliminarily record identification information for the track pitch information and/or the recording linear velocity information or the recording angular velocity information as well. It is possible to record the track pitch and/or the recording linear velocity or the recording angular velocity with a small amount of information by composing the track pitch information and/or the recording linear velocity information or the recording angular velocity information out of code information corresponding to discrete numeric values for the track pitch and/or the recording linear velocity or the recording angular velocity.

For example, the track pitch information and/or the recording linear velocity information or the recording angular velocity information can be recorded in a lead-in region, a program region, or a lead-out region. Especially for a recordable optical disk, such control information can be recorded by frequency modulation or as a pre-pit in a wobbling guide groove. For a read-only optical disk, the

control information can be recorded as main information or subcode information. In addition to the lead-in region, the program region, and the lead-out region, a mirror area radially inward of a track formation area can be used to record that information by section of a bar code arranged in the circumferential direction of the disk. This method is applicable to recordable optical disks and read-only optical disks. Further, in the case of a recordable optical disk, that information can be recorded on a track radially inward of a power calibration region by frequency modulation or as a pre-pit in the wobbling guide groove, or as main information, subcode information, etc.

A groove for guiding a track is formed in a wobbling manner on the optical disk according to the present invention with a specified frequency. Specified information is recorded in the guide groove of the optical disk (CD-R, CD-RW, etc.) by the frequency modulation. A combination of highest-order bits for respective digits in the BCD code represents a specified value on that optical disk. The aforementioned specified information is recorded so that low-order bits of the BCD code represent the track pitch information and/or the recording linear velocity information or the recording angular velocity information. In this case, the BCD code comprises 8-bit minute information, second information, and frame information. An undefined combination of highest-order bits for the minute information, second information, and frame information is selected to represent a specific value.

The aforementioned specified information can be recorded preliminarily so that low-order bits of the BCD codes represent the track pitch information and/or the recording linear velocity information or the recording angular velocity information. The aforementioned specific value comprises a combination of highest-order bits for the minute information, the second information, and the frame information and can represent any of "001", "010", and "011", for example. It is possible to use an undefined value other than the combination of highest-order bits of the minute information, the second information, and the frame information.

The optical disk according to the present invention is applicable to CD format read-only disks such as CD-DA, CD-ROM, etc., CD format recordable disks such as CD-R, CD-RW, etc., DVD format read-only disks such as DVD-ROM, DVD-video, DVD-Audio, etc., DVD format recordable disks such as DVD-R, DVD+RW, DVD-RW, DVD-RAM, etc., laser disks, magnet optical disks, and other disk-shaped optical recording media.

An optical disk apparatus according to the present invention records or reproduces information on the optical disk according to the present invention. The apparatus comprises: an optical pickup to read a signal from a specified position on the optical disk when it is loaded; an information acquisition section for acquiring the track pitch information and/or the recording linear velocity information or the recording angular velocity information from the read signal; and a control section for performing operations and

controls needed for recording or reproduction based on the acquired information. Just by reading the disk, it is possible to acquire these types of information. Accordingly, it is possible to eliminate the need for measurement, to acquire these types of information in a short time, and to shorten the time for preparing for recording or reproduction. When the track pitch information and/or the recording linear velocity information or the recording angular velocity information comprises code information corresponding to discrete numeric values for the track pitch and/or the recording linear velocity or the recording angular velocity, the apparatus further comprises a converter section for converting the code information to numeric values of the track pitch and/or the recording linear velocity or the recording angular velocity. The aforementioned control section can perform operations and controls needed for recording or reproduction based on the converted numeric values.

The optical disk according to the present invention is a recordable optical disk. The information about itself is preliminarily recorded on a track radially inward of the power calibration region or on the track formation area except the track radially inward of the power calibration region. This track formation area includes the program region, the lead-out region, the lead-in region, the PMA region, the PCA region, etc. According to this optical disk, just by reading the disk, it is possible to acquire the

information about itself. Accordingly, it is possible to eliminate the need for measurement, acquire the information about itself in a short time, and shorten the time for preparing for recording or reproduction.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a flowchart showing an embodiment 1 according to the present invention and exemplifying a control procedure for acquiring track pitch information and recording linear velocity information from ATIP information when a disk is loaded on a CD-R/RW drive apparatus;

FIG. 2 is a flowchart exemplifying a control procedure for acquiring track pitch information and recording linear velocity information when an optical disk of a constant recording linear velocity mode is loaded on a conventional optical disk apparatus;

FIG. 3 is a sectional view schematically showing arrangement of areas in the radial direction of a CD-R/RW disk;

FIG. 4 shows part of an ATIP information format for a lead-in region of the CD-R/RW disk;

FIG. 5 is a block diagram showing an embodiment which configures the optical disk apparatus according to the present invention as a CD-R/RW drive apparatus;

FIG. 6 shows an embodiment 2 according to the present invention, viewed from the recording surface side of the CD-R/RW disk;

FIG. 7 is a flowchart showing the embodiment 2 according to the present invention and exemplifying a control procedure for acquiring track pitch information and recording linear velocity information from bar code information when a disk is loaded on the CD-R/RW drive apparatus shown in FIG. 5;

FIG. 8 is a flowchart showing an embodiment 3 according to the present invention and exemplifying a control procedure for acquiring track pitch information and recording linear velocity information from a track formation area radially inward of the PCA region when a disk is loaded on the CD-R/RW drive apparatus shown in FIG. 5;

FIG. 9 shows part of a Q subcode information format for an EFM signal from the lead-in region on the CD-R/RW disk; and

FIG. 10 is a flowchart showing an embodiment 4 according to the present invention and exemplifying a control procedure for acquiring track pitch information and recording linear velocity information from the lead-in region when a disk is loaded on the CD-R/RW drive apparatus shown in FIG. 5 or a read-only disk drive apparatus.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following describes embodiments according to the present invention. First described is a case where the present invention is applied to a CD-R disk or a CD-RW disk (hereafter referred to as a CD-R/RW disk). The arrangement

of areas in the radial direction of the CD-R/RW disk is explained with reference to FIG. 3. A CD-R/RW disk 10 has an outside diameter of 120 mm and forms a center hole 12 at the center axis. A recording film formation area 14 is a recordable layer made of a pigment film and a reflective film, and comprises a track formation area 16 and mirror areas 18 and 20. On the track formation area 16, a pre-groove (guide groove) is preliminarily formed as a track. No track is formed on the internal circumference side of the mirror area 18 and on the external circumference side of the mirror area 20. The internal circumference side of the mirror area 18 may comprise only the reflective film without the pigment film. Within a diameter of 45 through 46 mm, there are formed a PCA region (Power calibration region) 22 and a PMA region (Program Memory Area) 24 from the internal circumference side. Within a diameter of 46 through 50 mm, a lead-in region 26 is formed. Between a diameter of 50 mm and the external circumference, a program region and lead-out region 28 is formed. An information recording area 30 comprises the PCA region 22, the PMA region 24, the lead-in region 26, the program region and the lead-out region 28 as a whole. The track formation area 16 is recorded approximately 30 seconds longer than the PCA region 22 toward the internal circumference. A track formation area 32 is formed as a free region radially inward of the PCA region (trial region) 22 and is not used conventionally. The pre-groove wobbles at a specified frequency and records ATIP (Absolute Time In Pre-

groove) information by frequency modulation. The ATIP information includes absolute time information at respective positions. Information is recorded in the form of pits along the tracks. The tracks are arranged spirally or concentrically at a predetermined pitch in the radial direction of the optical disk.

Embodiment 1

The following describes the first embodiment for recording the track pitch information and the recording linear velocity information as ATIP information on the lead-in region 26 during a disk manufacture process. FIG. 4 shows part of the ATIP information format on the lead-in region 26. This format contains time information MIN, SEC, and FRAME corresponding to minute, second, and frame at respective positions. Each information comprises an 8-bit BCD code representing two digits. The maximum value of MIN:SEC:FRAME on the lead-in region 26 is 99:59:74 (10011001:01011001:01110100). Of combinations of highest-order bits for MIN, SEC, and FRAME (M1, S1, F1), values "000" and "100" are used for the time information. Values "101", "110", and "111" are used as identification information for the ATIP special information. Any of the remaining values "001", "010", and "011" is used as identification information for the track pitch information and the recording linear velocity information. In this case, the track pitch information and the recording linear velocity information can be recorded by using low-order bits following highest-order

bits in MIN, SEC, and FRAME. The track pitch information and the recording linear velocity information comprise numeric values of the track pitch and the recording linear velocity. In addition, these types of information can comprise code information corresponding to discrete numeric values for the track pitch and the recording linear velocity. This enables the track pitch and the recording linear velocity to be recorded with a small number of bits.

Table 1 shows an example of the recording linear velocity information to be recorded as the ATIP information. Values S2, S3, and S4 correspond to the second, third, and fourth bits, respectively, from the highest-order bit of the 8-bit SEC (second information).

(Table 1)

| S2 | S3 | S4 | Corresponding recording linear velocity |
|---|---|---|---|
| 0 | 0 | 0 | 1.20 m/sec |
| 0 | 0 | 1 | 1.25 m/sec |
| 0 | 1 | 0 | 1.30 m/sec |
| 0 | 1 | 1 | 1.35 m/sec |
| 1 | 0 | 0 | 1.40 m/sec |
| | : | | : |

Table 2 shows an example of the track pitch information to be recorded as the ATIP information. Values F2, F3, and F4 correspond to the second, third, and fourth bits, respectively, from the highest-order bit of the 8-bit

FRAME (frame information).

(Table 2)

| F2 | F3 | F4 | Corresponding track pitch |
|---|---|---|---|
| 0 | 0 | 0 | 1.45 μm |
| 0 | 0 | 1 | 1.50 μm |
| 0 | 1 | 0 | 1.55 μm |
| 0 | 1 | 1 | 1.60 μm |
| 1 | 0 | 0 | 1.65 μm |
| | : | | : |

As mentioned above, the lead-in region 26 of the CD-R/RW disk 10 records the track pitch information and the recording linear velocity information as the ATIP information. FIG. 5 shows an embodiment of the CD-R/RW which records and reproduces information on the CD-R/RW disk 10. A spindle motor 34 drives the CD-R/RW disk 10. An optical pickup 36 records and reproduces information. A signal correction section 38 corrects time axes (irradiation start/stop timing and irradiation time) of a recording signal. A laser generation section 40 drives a laser source in the optical pickup 36 according to a recording signal having the corrected time axes, and records information on the disk 10. A storage section 42 stores: a converting table which represents relationship between a track pitch code and a discrete numeric value for the track pitch corresponding to that code; another converting table which represents relationship between a recording linear velocity code and a

discrete numeric value for the recording linear velocity corresponding to that code; a table which represents relationship between a recording linear velocity and the time axis correction amount for the recording signal; and a table which represents relationship between a recording linear velocity and the laser beam's recording power. An information acquisition section 44 acquires the ATIP information and other information (main information, subcode information, information needed for various servos, etc.) based on a returned light receiving signal detected by the optical pickup 36. The ATIP information of the lead-in region contains the track pitch information and the recording linear velocity information in the form of code information.

Based on the code information for the recording linear velocity acquired in the information acquisition section 44, a control section 46 reads a corresponding recording linear velocity value, the time axis correction amount for the recording signal, and the laser beam's recording power from the storage section 42. The time axis correction amount for the read recording signal and the laser beam's recording power are transferred to the recording signal correction section 38 and the laser generation section 40 as instruction values. The recording signal correction section 38 corrects the time axes of the recording signal based on instructions from the control section 46. The laser generation section 40 controls the laser beam's recording power based on an instruction from the control section 46. A

servo section 48 is responsible for rotation control of the spindle motor 34, and focus control, tracking control, track jump control, and feed control of the optical pickup 36. When provided with an instruction to access a given address on the disk 10, the control section 46 computes a target rotation number of the spindle motor 34 at the access destination and a track jump target distance to the access destination (or a target feed amount of the optical pickup 36). The computed value is sent as an instruction value to the servo section 48. The servo section 48 controls the rotation number according to the instruction value and performs the track jump control and the feed control of the optical pickup 36.

The following exemplifies a control procedure for acquiring the track pitch information and the recording linear velocity information with reference to FIG. 1 when a disk is loaded on the CD-R/RW drive apparatus shown in FIG. 5. When a disk is loaded (S11), it is determined whether a CD-R/RW disk or other disks are loaded according to presence or absence of the ATIP information (S12). When a CD-R/RW disk is used, the ATIP information is read from the lead-in region (S13). The track pitch information and the recording linear velocity information are acquired from the ATIP information (S14). Thus, the information about the track pitch and the recording linear velocity has been acquired (S15). When the other disks are used, another processing is performed (S16).

Embodiment 2

FIG. 6 shows an embodiment for recording the track pitch information and the recording linear velocity information on a mirror area radially inward of the track formation area during a disk manufacture process by using a bar code arranged in the circumferential direction. The recording film formation area on the CD-R/RW disk 10 contains the mirror area 18 radially inward of the track formation area 16. The mirror area 18 contains an area which comprises a layer of the pigment film and the reflective film or comprises just the reflective film. This area records the track pitch information and the recording linear velocity information by a section of a bar code 50 arranged in the circumferential direction. Using the CD-R/RW drive apparatus shown in FIG. 5, the optical pickup 36 can read the bar code 50 prior to recording and reproducing of information on this CD-R/RW disk 10.

The following exemplifies a control procedure for acquiring the track pitch information and the recording linear velocity information from the bar code 50 with reference to FIG. 7 when a disk is loaded on the CD-R/RW drive apparatus shown in FIG. 5. When a disk is loaded (S21), the spindle motor 34 is driven. The optical pickup 36 is positioned to the mirror area 18 toward the internal circumference. The optical pickup 36 reads the bar code 50 (S22). The track pitch information and the recording linear velocity information are acquired from the read bar code

information (S23). Thus, the information about the track pitch and the recording linear velocity has been acquired (S24).

This information recording method using the bar code can be applied to not only CD-R/RW disks, but also other standardized recordable optical disks and read-only optical disks. In this case, a disk of the constant recording angular velocity mode can record the recording angular velocity information instead of the recording linear velocity information.

Embodiment 3

The following describes an embodiment for recording the track pitch information and the recording linear velocity information on the track formation area radially inward of the power calibration region during a disk manufacture process. The free track formation area 32 radially inward of the PCA region 22 or the trial region on the CD-R/RW disk 10 in FIG. 3 records the track pitch information and the recording linear velocity information in any form of the ATIP information, the pre-pit information, the EFM signal's main information, the EFM signal's subcode information, and other information. Using the CD-R/RW drive apparatus shown in FIG. 5, the optical pickup 36 can read information from the track formation area 32 radially inward of the PCA region 22 prior to recording and reproducing of information on this CD-R/RW disk 10.

The following exemplifies a control procedure for acquiring the track pitch information and the recording linear velocity information from the track formation area 32 radially inward of the PCA region 22 with reference to FIG. 8 when a disk is loaded on the CD-R/RW drive apparatus shown in FIG. 5. When a disk is loaded (S31), it is determined whether a CD-R/RW disk or other disks are used according to presence or absence of the ATIP information (S32). When a CD-R/RW disk is used, information is read from the track formation area 32 radially inward of the PCA region 22 (S33). According to this information, the track pitch information and the recording linear velocity information are acquired (S34). Thus, the information about the track pitch and the recording linear velocity has been acquired (S35). When the other disks are used, another processing is performed (S36).

It is possible to apply this information recording method using the track formation area radially inward of the power calibration region to not only CD-R/RW disks, but also other standardized recordable optical disks. A disk of the constant recording angular velocity mode can record the recording angular velocity information instead of the recording linear velocity information. It is possible to record control information needed for recording or reproduction other than the track pitch information, the recording linear velocity information, and the recording angular velocity information.

Embodiment 4

The following describes an embodiment for recording the track pitch information and the recording linear velocity information on the lead-in region during a disk manufacture process. The lead-in region on the optical disk records the track pitch information and the recording linear velocity information provided with an undefined identification code in any form of the ATIP information, the pre-pit information, the main information (for read-only disks), the subcode information (for read-only disks), and other information.

The following describes a case where the track pitch information and the recording linear velocity information are recorded as the EFM signal's Q subcode information on the lead-in region of a read-only formatted CD such as CD-DA, CD-ROM, etc. FIG. 9 shows part of the Q subcode information format on the lead-in region. This format contains time information MIN, SEC, and FRAME corresponding to minute, second, and frame at respective positions in the lead-in region. Each information comprises an 8-bit BCD code representing two digits. The maximum value of MIN:SEC:FRAME on the lead-in region 26 is 99:59:74 (10011001:01011001:01110100). Of combinations of highest-order bits for MIN, SEC, and FRAME (M1, S1, F1), values "000" and "100" are used for the time information. Any of the remaining values "001", "010", "011", "101", "110", and "111" is used as identification information for the track pitch information and the recording linear velocity information.

In this case, the track pitch information and the recording linear velocity information can be recorded by using low-order bits following highest-order bits in MIN, SEC, and FRAME. The track pitch information and the recording linear velocity information comprise numeric values of the track pitch and the recording linear velocity. In addition, these types of information can comprise code information corresponding to discrete numeric values for the track pitch and the recording linear velocity. This enables the track pitch and the recording linear velocity to be recorded with a small number of bits.

The recording linear velocity information can be recorded as the EFM signal's subcode information likewise the data shown in the aforementioned Table 1, for example. The track pitch information can be recorded as the EFM signal's subcode information likewise the data shown in the aforementioned Table 2, for example.

Using the CD-R/RW drive apparatus shown in FIG. 5 or a read-only disk drive such as a CD-ROM drive, a DVD-ROM drive, etc., the optical pickup can read control information from the lead-in region prior to recording and reproducing of information on this read-only formatted CD.

The following exemplifies a control procedure for acquiring the track pitch information and the recording linear velocity information with reference to FIG. 10 when a disk is loaded on the CD-R/RW drive apparatus shown in FIG. 5 or the read-only disk drive. When a disk is loaded (S41),

information is read from the lead-in region (S42). The track pitch information and the recording linear velocity information are acquired from the information which is read from the lead-in region (S43). Thus, the information about the track pitch and the recording linear velocity has been acquired (S44).

The track pitch information and the recording linear velocity information can be recorded on the information recording area except the lead-in region such as the program region or the lead-out region. It is possible to apply the method of recording control information about the disk itself using the information recording area including the lead-in region, the program region, the lead-out region, etc. to not only CD format disks, but also other standardized recordable optical disks and read-only optical disks. In this case, a disk of the constant recording angular velocity mode can record the recording angular velocity information instead of the recording linear velocity information.